

# ON THE ROAD AGAIN

by Vicki Speed

In the December 1993/January 1994 issue, POB reported on a mobile surveying system that appeared to be safer, cost less, and perform as fast as conventional methods while delivering design standard accuracy. At the time, the California Department of Transportation (Caltrans), by working closely with the system developer—Longdin & Browning of the United Kingdom and the U.S. representative, Psomas & Associates—pioneered one of the first DOT evaluations of this technology, primarily in the Sacramento and southern California areas, with great success.

## Mobile surveying gains momentum in California.

"I'm glad I'm not on the roads anymore," says Stan Schram, assistant land surveyor for the California Department of Transportation (Caltrans), District 4, recalling a particularly harrowing experience. "I was in the middle of a highway surveying job that required our team to gather topographic data of a six-lane highway for a

redesign effort. Before I could blink, a semi truck went by close enough to almost touch." The incident occurred while Schram stood in the closed lane of a Contra Costa County freeway holding a prism pole. A rapidly approaching semi truck skidded out of control and plowed through the 1,500' of orange cones, passing within 2' of Schram:

"All I heard was the crushing of the plastic cones," he says.

Schram no longer performs all topographic surveys with conventional technology. Instead, he and other surveyors at Caltrans can be found inside an odd-looking, orange and white van, parked on the shoulder or median of public highways in the Bay area. The unusual vehicle is a mobile surveying system called the Vangarde 505 and is part of an agency-wide effort to find, test and implement safer surveying techniques. The Vangarde 505 (then called the Clear Cone Survey System) was originally developed in Great Britain in the late 1980s. Earth Vectors Company (Irvine, Calif.) manufactures the vans in the United States, using technology tested and evaluated by Psomas & Associates, a Costa Mesa, California-based engineering, surveying and land planning firm. Caltrans District 4 purchased the system in 1995 to support pavement elevation data gathering for resurfacing or reconstruction efforts on the region's highways, which cover nine counties including San Francisco, Alameda and Santa Clara.

The system is unique because it replaces the prism pole with reflectorless infrared light technology that allows the surveyor to accurately gather data remotely. According to Schram and the other surveyors trained on the system, mobile surveying is safer, faster, and more cost-effective



Photo courtesy of Caltrans.

The Caltrans mobile surveying system, the Vangarde 505.

Since then, that system has generated surprisingly limited interest from other transportation agencies, while at Caltrans its applications are growing. The latest is in the San Francisco-Oakland area district of Caltrans, where it has become an integral part of surveying operations providing both better and safer business processes. In the following article, we'll re-examine this unique system and its capabilities. Is it really a viable alternative to conventional surveying techniques? What are its limitations? And does Caltrans know something that the rest of the industry doesn't?

than anything they've ever used for pavement elevation data gathering—and it provides design accuracy to within two millimeters. Schram adds that in just the few months since purchasing the system, he and two other surveyors have become so proficient that they can measure 200' of freeway cross section in six minutes flat.

Similar jobs using conventional tools could perform about as quickly but would require shutting down lanes, a minimum of four surveyors, and put surveyors, like Schram, on the highway with just a row of orange cones between them and passing motorists. "Thanks to mobile technology, topographic surveying on active highways has become a point and shoot process," Schram says.

## The Added Edge of Reflectorless Infrared Light

Other than the cylindrical cone that protrudes from the van roof, the Vangarde 505 vehicle looks and drives much like any other standard automobile. It comes with air conditioning, a towing package and more, including the buyer's choice of color (safety orange seems to be the most popular thus far).

It's what's inside that really makes the difference. The back of the van incorporates a hydraulic suspension platform that raises the operator, seated in a captain's chair, well above the roadway surface into the van turret. From this vantage point, the surveyor can manipulate an array of surveying tools such as a total station, an electronic distance-measuring device (EDM) and a laptop computer with specialized software that automatically records and displays the data in real time. To minimize movement by passing motorists, the surveying equipment is mounted on an isolated tripod that can be hydraulically lowered on the ground through the bottom of the van. Foot pedals allow the operator to spin the turret to the left or right while gathering data along the roadway.

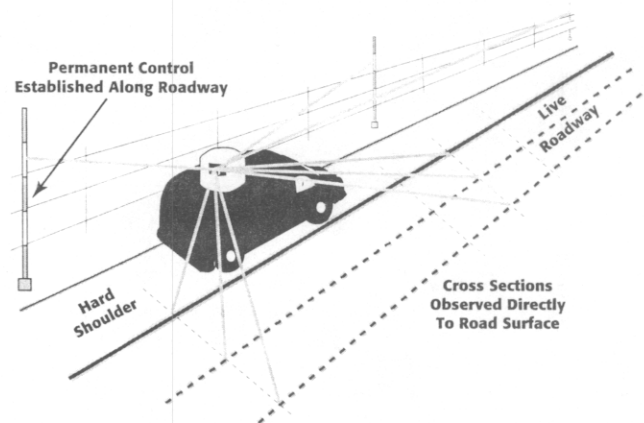
What makes this system unique technology-wise is the reflectorless infrared light technology built into the EDM. Typical infrared EDMs rely on a prism or mirror to reflect from a target. Reflectorless EDMs emit a timed, pulsed infrared light beam to "hit" a position and then bounce back to the EDM. In a fraction of a second, the operator knows the exact distance to the target. In the Vangarde 505, the EDM is combined with a theodolite. By simply pushing a button on the theodolite, the EDM measures the distance to the target while the theodolite measures the horizontal and vertical angle.

Parked on the shoulder or median of the highway, the operator can quickly locate a section of roadway by pointing the EDM at the designated target, pushing a button and then rotating the turret to the next target. Once all pavement elevations are gathered for a particular section, the driver of the van moves forward to the next section, where the process begins once again.

A laptop computer connected to the surveying equipment records the data in real time. From there, surveyors post-process the information into the district's CAD or surveying software packages. Schram adds: "We had a programmer at the district office write a custom translation program that automatically translates the information from the Vangarde software into the district's total station surveying software."

To date, District 4 has used the Vangarde system every day that has been sunny or nice. The surveyors average about 500 shots per day, which covers about one-half or three-quarter miles of topographic detail work. It typically requires two or three people depending on the job. "If it is a real clear site without much traffic, we operate with two people. If it is a rush job, we'll run with three," Schram says.

Typical jobs involve resurfacing or reconstruction efforts that require accurate topographic data, although it has been used in other ways as well. Schram and his team recently used the Vangarde data gathering capabilities to help resolve a dispute between Caltrans and a subcontractor. The two parties disagreed on the amount of asphalt used for a particular roadway resurfacing. "We went out and shot the one-mile section of the eight-lane highway



The Vangarde 505 allows for a safe topographic survey of an active roadway surface, without interrupting the normal flow of traffic.

that was in question, calculated the area and provided it to both parties within two days. To do this with conventional tools would have required shutting down several lanes and cost the district a significant amount of money. For much less, both parties have all the information easily and quickly, and can begin ironing out the differences."

## Working Within Technological Boundaries

It's important to note that the Vangarde 505 doesn't eliminate all surveying needs during a topographic data gathering effort, particularly concerning control. "Many of our roads do not have pre-established supplementary control. Naturally, that must be completed prior to surveying, and does require those surveyors to step out onto at least the shoulder of an active highway," Schram says.

In addition, the system requires some training. Caltrans District 4 surveyors attended a one-week training class provided by the vendor, Earth Vectors Company, that covered everything from how to operate the van to hands-on training inside the hydraulic turret. Surveyors agreed that the learning curve is short for the Vangarde and, that when they do have questions, the manual has provided the necessary answers.

Reflectorless infrared technology also has limitations. Schram and his team say that they must keep shots under



Photo courtesy of Caltrans.

This system uses a reflectorless infrared light technology that enables the surveyor to gather data remotely.

50 m to maintain the agency's tight accuracy requirements. Distances any farther create more error in the distance measurement.

Schram and his team have also noted that the system doesn't work well on brand-new blacktop because the infrared light beam has difficulty returning a signal from the roadway surface. Lastly, the system doesn't perform well on wet pavement, once again because the infrared light beam is extremely sensitive to the light scatter caused by water.

Overall, say surveyors in District 4, the system is doing its job. "I'm booked for the next six months for projects using the Vanguard 505," Schram says, "and I'm sure, with a little thought, we can keep it booked for the next six years."

## Future Directions

Without a doubt the most significant benefit of the Vanguard 505 system is the improved safety to surveyors by getting them off the road during pavement elevation survey jobs. It also provides some impressive cost savings to the transportation agency. Officials estimate that the cost of shutting down lanes in this part of California is about \$6,000 per day to close one lane for one mile. As Schram says, "You just don't shut down a major highway, such as San Francisco's I-80, without upsetting a lot of the traveling public and running up a pretty high bill. Just a few quick calculations and it's very easy to see where the Vanguard would pay for itself very quickly."

Caltrans District 4 is not the only district in California to take advantage of the system. After the initial U.S. demonstration surveys were performed in District 7 in Los Angeles in 1992, District 8 in San Bernardino leased and later purchased the system in 1993.

It has proved so useful to District 8 that it has almost completely replaced conventional means of surveying pavement elevation data. Considering their success and subsequent test jobs performed in the Bay area using District 8's Vanguard system, officials in District 4 set out to buy one of their own. Other DOTs and transportation-related agencies across the country have started looking into the Vanguard



Photo courtesy of Caltrans.

A hydraulic suspension platform raises the operator into the van turret, where a number of surveying tools are available.

system more recently. Several have used it for pilot projects or one-time jobs. But Caltrans remains the only one to rely on the system as an alternative means of surveying.

When asked about the system and its potential to replace existing surveying methods, District Survey Engineer Nelson Aguilar commented that mobile technology is a significant addition to the region's growing technology arsenal, which includes GPS. But, he says, it will not replace any tools—simply accent them. "For instance, there are going to be projects that are more appropriate for the Vanguard and some for the GPS. What we are finding is that a combination of technology is really the most efficient way of doing a project. We have already had a situation where GPS has been used to set control in a fast-static mode, while right behind came the Vanguard tying into that control and gathering the pavement elevation data."

In the meantime, for Stan Schram and other surveyors who have had near-death experiences on the fast-paced highways of California, the Vanguard 505 is a welcome addition.

For more information about Caltrans' use of the Vanguard 505 system, contact Mark Turner, district office chief of Right of Way Engineering, Surveys, and Mapping Services at 510/286-4999.

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